Chapter 10

Traditional Conservation areas of Coconut Varieties and Associated Knowledge in Polynesian Islands (South Pacific Ocean)

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Abstract

By summarizing surveys conducted on 27 islands of the Pacific region, this chapter reports some traditional knowledge associated with coconut genetic resources and explains how this knowledge has strongly contributed to formulating the concepts and strategies in the conservation of genetic resources. Polynesians have used small islands as conservation areas for their coconut varieties. Since 1930, the number of coconut palms increased but the varieties mixed and the related traditional knowledge dwindled. Based on traditional Polynesian knowledge, the *Polymotu* concept uses the geographical isolation of special sites for the conservation and reproduction of varieties of coconut. For instance, when isolated site on island is planted with one variety of coconut, breeding occurs only within this variety and certified drupes are

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then available to farmers. In 2009, the *Polymotu* concept was included in the global coconut conservation strategy developed by the International Coconut Genetic Resources Network. However, traditional coconut varieties and associated knowledge are continuing to disappear. Decision-makers at the local, national and international levels should adopt effective portfolios of strategies and gender-sensitive guidelines to ensure both the effective conservation of coconut genetic resources and associated knowledge, and the availability of diversified planting material for replanting programs.

Key Words: Genetic resource, *Cocos nucifera*, traditional knowledge, conservation strategy, Polymotu, Polynesia.

Résumé

Basé sur des enquêtes menées dans 27 îles de la région Pacifique, ce chapitre fait état de quelques savoirs traditionnels liés aux ressources génétiques du cocotier et aborde comment ces savoirs ont fortement contribué à la formulation de concepts et stratégies de conservation des ressources génétiques. Les Polynésiens utilisaient de petites îles comme conservatoires pour leurs variétés de cocotier. Depuis 1930, le nombre de cocotiers s'est accru, les variétés se sont mélangées, et les savoirs locaux tendent à disparaître. Basé sur les savoirs traditionnels polynésiens, le concept *Polymotu* consiste à utiliser l'isolement géographique de sites pour la conservation et la reproduction de variétés de cocotier. Ainsi, lorsque plusieurs sites d'une petite île sont plantés avec quelques variétés de cocotier, des semences certifiées peuvent être produites pour les agriculteurs. L'objet de ces conservatoires est de promouvoir l'utilisation d'un matériel végétal diversifié pour les programmes de replantation. En 2009, ce concept a été inclus dans la stratégie globale de conservation développée par le réseau international des ressources génétiques du cocotier (COGENT). Cependant, dans la région Pacifique, les variétés traditionnelles de cocotier et les savoirs associés continuent de disparaître. Les décideurs, aux niveaux local, national et international, devraient adopter des lignes directrices afin d'assurer une conservation efficace des ressources génétiques du cocotier et des savoirs associés.

Mots-clés : ressources génétiques, *Cocos nucifera*, savoirs traditionnels, stratégie de conservation, *Polymotu*, Polynésie.

1. Introduction

Ethnobiological studies provide useful tools for the development of biodiversity conservation policies (Toledo *et al*. 2009). Since the Barbados Conference in 1994, biodiversity resources have been considered a key factor in shaping sustainable development strategies for island regions (Zedan 2004). Their geographical circumstances and their distance from the mainland have been identified as the main causes of unique evolutionary dynamics, which have made island biota not only fragile but also highly productive in terms of biodiversity (Dahl 1984; Mueller-Dombois 2002; Stoddart 1992). Because of their geographic remoteness, which ensures the isolation of the organisms living there, tropical islands are home to an

extraordinarily high proportion of endemic species, as well as crop varieties and related traditional knowledge.

Cocos nucifera L. (Arecaceae), commonly called the coconut palm, remains one of the crops most neglected by scientists, with regard to its economic value and cultural importance (Bourdeix *et al*. 2011a). Coconuts support sustainable livelihoods, providing materials for food and shelter, helping to stabilize farming systems, and generating income and employment. More than 95% of all coconut growers are smallholders and more than 11 million rural families depend on coconut for their income (Core 2006). Benefits from better access to improved planting material and management, to post-harvest technologies and to new marketing opportunities are likely to accrue to the poorest rural populations of the Pacific region.

In 1998, in the framework of the International Coconut Genetic Resources Network (COGENT), IPGRI (now Bioversity International) organized two simultaneous workshops, in Fiji and the Philippines, on farmer participatory research into coconut genetic resources. The resulting book (Eyzaguirre and Batugal 1999) served to train researchers (including the corresponding author) in Rapid Rural Appraisals (RRA) and Participatory Rural Appraisals (PRA), as also described by King (1999).

Between 1997 and 2011, around 13 months of fieldwork were devoted to scientific surveys conducted with local researchers on 27 tropical islands in the Pacific region (Table 1). The main purpose of these surveys was to produce inventories of coconut varieties and associated traditional knowledge. The surveys carried out during this 15-year period were not initially planned as a unique study. From 1997 to 2001, the main methodologies used were PRA and RRA. Interviews were mainly orientated toward producing lists of traditional varieties supported by local names, recording the uses and knowledge specific to these varieties, visual observation of palms and, when possible, fruit component analysis as described by Santos *et al*. (1996). A total of about 350 people were interviewed between 1997 and 2001. From 2002 onwards, although some additional interviews with groups were still conducted, semi-direct interviews of individuals were preferred.

Inventories of coconut varieties were first reported in several reports (*e.g*. Fili 2000; Pouono 2000; Labouisse and Sileye 2001; Labouisse and Bourdeix 2003; Bourdeix 2006a), and a book (Bourdeix 2006b). Other activities were also carried out during these surveys, such as: reviewing breeding programs (Bourdeix 1998; Labouisse *et al*. 2004, 2005; Batugal and Bourdeix 2005); developing coconut germplasm information systems (Hamelin *et al*. 2005; Bourdeix *et al*. 2012a); mapping and locating coconut diversity (Bourdeix *et al*. 2005a; Ramanatha Rao *et al*. 2005); addressing gaps in collecting strategies (Bourdeix *et al*. 2005b) and editing catalogues of coconut germplasm (Bourdeix *et al*. 2005c, 2010).

Table 1. Countries, high islands and atolls surveyed in the Pacific region.

Country	High islands and atolls surveyed	Years of surveys
Vanuatu	Efate, Espiritu Santo	1997, 2000, 2001
Cook Island	Rarotonga, Aitutaki	2000
Papua New Guinea	New Guinea, New Britain	1997
Tuvalu	Funafuti, Vaitupu, Nui, Nukufetau	2000
Tonga	Tongatapu, Vava'us	1998
Samoa	Manono, Savai, Upolu	2001, 2010
Fiji	Taveuni, Viti Levu	2001, 2010
French Polynesia	Aratica, Fakarava, Moorea, Nuku Hiva, Raiatea, Rangiroa, Tahiti, Tetiaroa, Taaha, Tubuai	2006, 2009, 2010, 2011

Overall, in the Pacific region, traditional coconut varieties and associated knowledge are rapidly disappearing (Bourdeix *et al*. 2009). There are now comprehensive reasons, urgent needs and international commitment to safeguard the remaining diversity. The issue now is to evolve from conservation strategies and international recommendations to local, regional and international conservation policies and projects which will be efficiently and effectively implemented.

This chapter is devoted to Polynesian traditional knowledge and representations linked to coconut genetic resources, and explains how traditional knowledge has strongly contributed to formulating new concepts and strategies in the conservation of genetic resources and biodiversity. The aim of the chapter is to support conservation strategies and the use of genetic resources of *Cocos nucifera* and associated knowledge in the Pacific Islands.

2. Coconut, insularity and related traditional knowledge

2.1. Polynesian classification of coconuts as "female and male"

In their traditional knowledge, Polynesians categorize coconuts (*i.e*. dry drupes) and coconut palms as female and male according to four distinct classification systems. One female/male descriptive grouping is linked to the shape of the fruits; two more groupings are linked to the way fruits germinate; and the last one is linked to the general appearance of the palm. "Females" are always preferred to "males" as planting material.

The first classification is linked to the shape of the distal part of the coconut husk (Fig. 1). If it is pointed with a small nipple, Polynesians will classify the fruit as "male". If the 3 protuberances terminate by a concavity, the fruit will be called "female". Three informers from different islands said that it was much easier to remove the husk from these "female" fruits than from these "male" fruits. During traditional Polynesian festivals, competitions are organized for the speediness of removing the coconut husk. In Aratika, we met a competition winner who told us that he won because he was able to select these "female" coconuts from the heap of fruits available to participants. He also told us that the rule of these competitions had recently

been modified. Nowadays, participants can no longer choose the fruits for removing the husk; they each receive a separate batch of randomly selected coconuts.

Figure 1. First female/male classification of coconuts: shape of the distal part of the coconut husk. Left: female; right: male.

The second classification is linked to the way the sprout emerges from the husk when germinating (Fig. 2). If it emerges from the place originally occupied by the peduncle, the fruit is called “female”. If it emerges from elsewhere, the fruit is called “male”. Our first observation tends to indicate that the fruits germinating as “female” have a thinner husk and a bigger coconut inside, so the sprout can easily emerge through the husk at the peduncle level. This could be checked more precisely by conducting a scientific experiment comparing the size and composition of these “female” and “male” fruits after growing them in a nursery.

Figure 2. Second female/male classification of coconuts: the way the sprouts emerge from the husk when germinating. Left: female; right: male.

The third characterization occurs when seedlings in the nursery are aged from one to two months (Fig. 3). Those having large, wide and oblong first leaves are said to be “female” while seedlings with long narrow first leaves are said to be “male”. This variation in leaf shape could originate from genetic differences between the seedlings. The coconut palm has an intermediate reproductive system. Most of the fruits result from the crossing of two coconut palms but some come from self-pollination of the mother palm and, as there is an inbreeding depression, the resulting coconut palms produce 20 to 30% less than average. By selecting “female” seedlings, Polynesians may remove those originating from self-pollination. This could be checked by conducting a genetic experiment comparing the DNA structure of “female” and “male” seedlings after growing them in a nursery.

Figure 3. Third female/male representation of coconuts. Left: female; right: male.

The fourth female/male classification deals with the general appearance of the adult coconut palms. A fecund and productive palm, producing many coconuts, is called “female” while one producing few or no coconuts is called “male”.

These four female/male Polynesian classifications do not fit with the “botanic reality” of scientists who classify all coconut palms as both male and female. Nevertheless, these methods seem efficient in the sense that they allow people to select better coconut palms. This study needs to be complemented by further genetic experiments which will qualify and quantify precisely the efficiency and efficacy of Polynesian selection criteria. Commitment from Polynesian institutions and associated budgets will be needed to conduct these additional studies.

In the Pacific region, the technical knowledge of coconut farmers regarding coconut biology remains weak. For instance, in French Polynesia, among 93 coconut farmers and growers interviewed on 10 islands, 80% of them did not know that the inflorescence of a coconut palm has both female and male flowers. This may originate from an incompatibility between the traditional female/male representations and botanical knowledge. In any case, the situation is quite similar at an international level even for those not using such female/male typology.

Most coconut growers have the practical experience of harvesting drupes from a coconut palm selected for a specific purpose (high yield, sweet coconut milk, sweet husk) and obtaining different characteristics from the progeny; but most of them

do not know why. This occurs because they choose the mother palm but, as the Tall-type coconut palms are mainly allogamous, the pollen comes mostly from an unknown male parent, which transmits unwanted characteristics to its progeny.

2.2. *Motu* born from coconut palms

During 2009, the IFRECOR (French Initiative for Coral Reefs) funded a scientific survey on the atoll of Fakarava (Tuamotu, French Polynesia). At this time, Mr. Cyril Tshonfo Ayee, known as Tehira, was president of the Association of the Biosphere Reserve of the Municipality of Fakarava. Tehira indicated that, for the Polynesian, a *motu* is defined as a small island on which vegetation grows. A rock islet and a sandbar without any vegetation are not called *motu*. Tehira observed some sandbanks becoming small *motu* over a number of years. According to him and some other inhabitants of Fakarava, "the coconut tree can create a *motu*." Tehira explained that coconuts brought by the sea germinate on a sandbar which has not yet stabilized (Fig. 4). If the coconuts succeed in germinating and growing, birds come to rest on the young coconut palms. They then carry seeds on their feathers or in their droppings which are deposited on the sand around the coconut. Bird droppings enrich the soil. In most cases, only a single coconut palm manages to survive to adulthood. Gradually, vegetation grows at the foot of the palm(s). The palm(s) roots and the other plants contribute to stabilizing the sandbar and provide purchase for other coconut seedlings and other seeds to germinate and flourish. Thus, the size of the *motu* progressively increases.

Tehira also indicated that, when travelling on uninhabited *motu*, the Polynesians of Fakarava take coconut seedlings onto the beach of the *motu* and plant them in its central area. As far as he remembers, people of Fakarava rarely bring coconut seedlings from the inhabited *motu* to the uninhabited *motu*. Despite this, we met some *motu* owners from Fakarava claiming that they had recently planted some coconut hybrids on their *motu*.

2.3. Traditional conservation areas

The oldest description of coconut varieties in French Polynesia can be found in the book "Ancient Tahiti" by Teuira Henry, published in 1928 from data collected by her grandfather in 1840. Teuira Henry reported that the Tahitians knew of the existence of particularly enormous round coconuts growing on the island of *Niu-Fou* (now known as *Niuafo'ou*, Tonga Islands). This tiny remote island in the Tonga group is located about 200 km from the nearest island and has the shape of a split coconut (Fig. 5). *Niuafo'ou* is a very active volcano that slopes steeply down to the sea floor and provides no safe anchorage for boats. Its name means "New coconut". More than 150 years ago, Tahitians were aware of the existence of the special coconut variety conserved on this small island located more than 2,800 km from Tahiti.

Figure 4. Islands said to be "born from a coconut palm" by local informers. The different stages as observed in Fakarava (Tuamotu, French Polynesia).

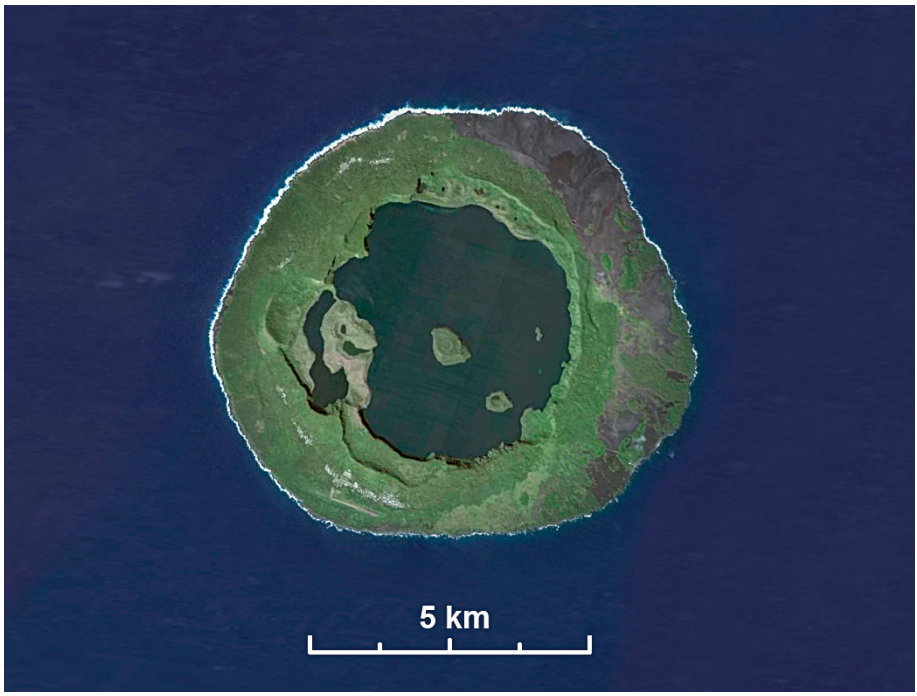

Figure 5. Traditional conservation area: satellite image of *Niuafo'ou* island, Tonga (source: Google Earth, Digital Globe Catalog ID: 1010010004FEB901; 28th May 2006).

Another example of a traditional conservation area also comes from Tonga. In 2001, we visited numerous Pacific islands in the framework of surveys organized by Bioversity International. L. M. Fili and T. H. Hoponoa, from the Ministry of Agriculture and Forestry of Tonga, told us about the highly prized, traditional coconut variety called "*Niu utongau*". This variety belongs to a rare form of coconut, severely threatened, known as "Sweet husk" because the husk of unripe fruits, which is usually tough and astringent, is tender, edible and sweet. It can be chewed like sugarcane and its taste resembles that of coconut heart. Once the fruits are ripe, the husk fibers are white and thin. There are various names and various types, in which husk characteristics are more or less accentuated - more or less sweet, more or less smooth. For some varieties, the ripe fruit can be husked by hand, which is impossible with an ordinary coconut. These varieties have yet to be scientifically described. According to Tongans, the "*Niu 'utongau*" coconut variety can be found in quantity only on the small coral islet (*motu*) of Onoiki in the Ha'apai group (Fig. 6). Tongans still sometimes take seedlings from this *motu*, which is too small to appear on most maps.

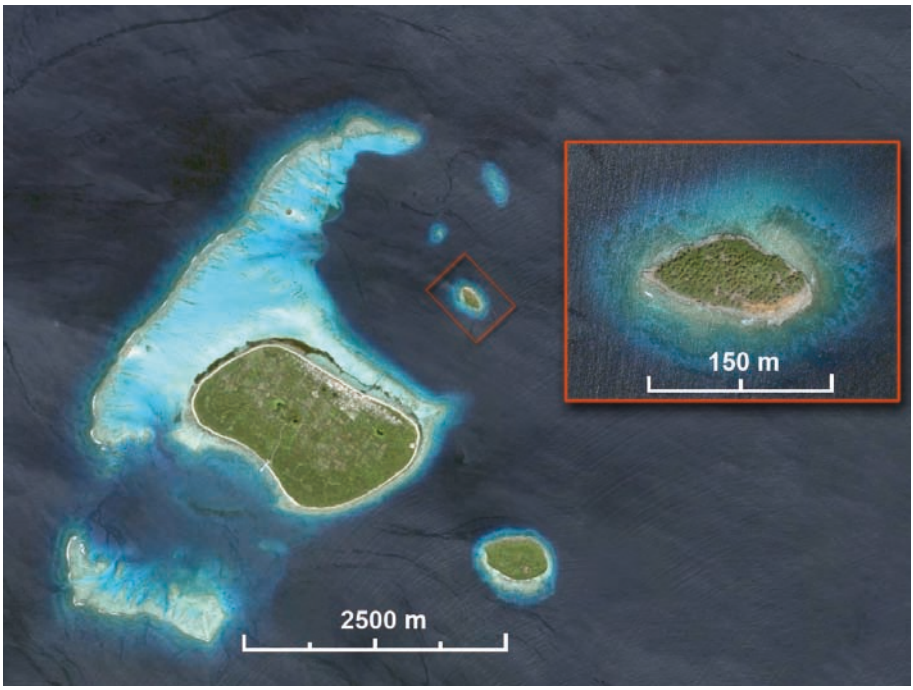

Figure 6. Traditional conservation area: satellite image of the motu *Onoiki* in the *Ha'apai* group, Tonga (source: Google Earth, Digital Globe Catalog ID: 1010010004CA5C01, 4th February 2006).

Another isolated place famous for its coconuts is Rennell, a high volcanic island located in the Solomon archipelago, with an area of 660 km². Its two main features are its volcanic lake, now registered as a world heritage site, and its Polynesian population. Other Solomon Islands are mainly populated by Melanesians. Except for the very small island of Bellona, also populated by Polynesians, the distance from Rennell to the nearest island is 170 km. The fruits of the variety known as Rennell Island Tall (RIT) are among the biggest coconuts in the world. Most of them have an unusual pointed pear shape (Fig. 7). The role of Rennell Island as a traditional conservation area has not been proven, as we did not record any information that other islanders know this place and use it for exporting coconuts. In any event, Rennell Lake is an example of a remote location conserving a unique coconut variety, which is now involved worldwide as parental material in many coconut breeding programs.

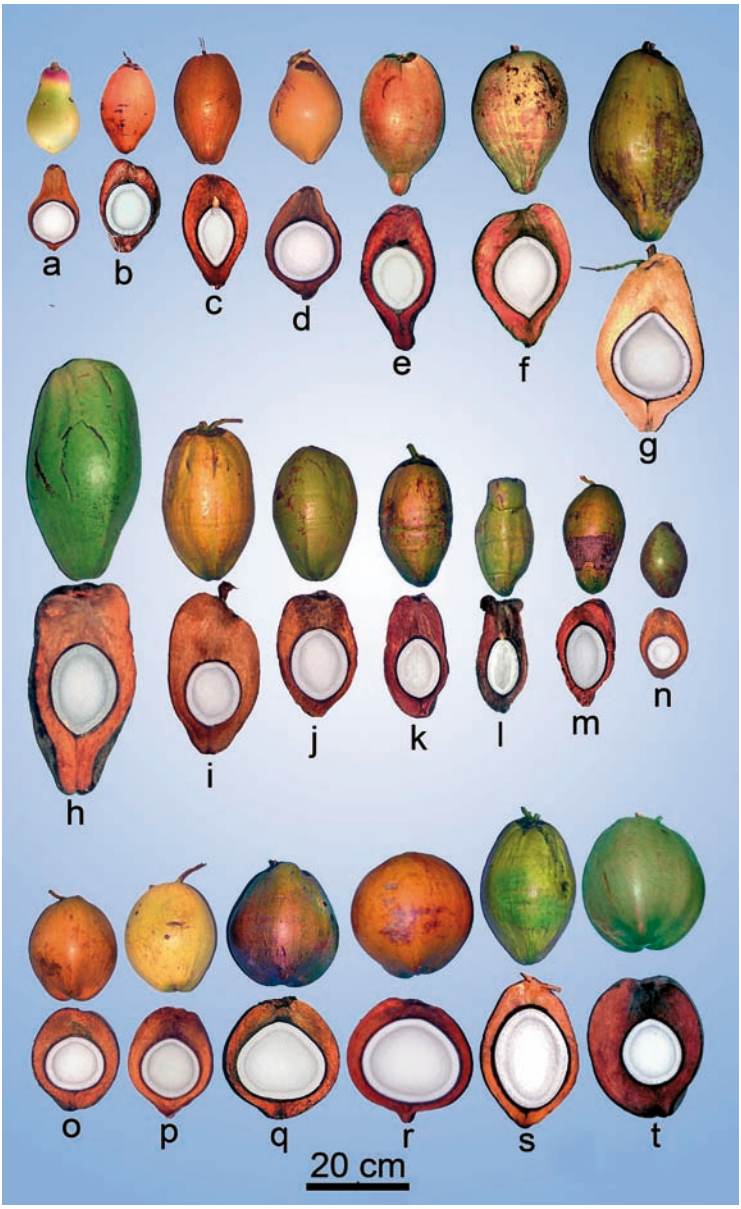

Figure 7. Genetic diversity of the fruits of various coconut varieties (Bourdeix *et al*. 2005c) with, from left to right, then top to bottom: first row (a) Papua Yellow Dwarf (PNG), (b) Tahiti Red Dwarf (French Polynesia), (c) Madang Brown Dwarf (PNG), (d) Cameroon Red Dwarf (Cameroon), (e) Spicata Tall Samoa (Western Samoa), (f) Rotuman Tall (Fiji), (g) Rennell Tall (Solomon Islands); second row (h) *Niu afa* Tall (Western Samoa), (i) Comoro Moheli Tall (Comoro Islands), (j) Sri Lanka Tall Ambakelle (Sri Lanka), (k) West African Tall Akabo (Ivory Coast), (l) Tuvalu Tall Fuafatu (Tuvalu Island), (m) West African Tall Mensah (Ivory Coast), (n) Micro Laccadives Tall (India); third row (o) Vanuatu Tall (Vanuatu), (p) Malayan Yellow Dwarf (Malaysia), (q) Malayan Tall (Malaysia), (r) Tagnanan Tall (Philippines), (s) Tampakan Tall (Philippines) and (t) Kappadam Tall (India).

3. A diachronic approach to coconut history in the Pacific region

Regarding the *in situ* conservation and preservation of associated local knowledge, it was important to understand better the biological, social and historical dynamics which are shaping coconut biodiversity and its uses. Such a diachronic approach was recently developed for the coconut palm in the Pacific region (Bourdeix *et al*. 2009).

On many islands of the Pacific region, the same kind of dynamics has already occurred. In the 1800s, island families each had a limited number of coconut palms, but there were many coconut landraces serving widely differing purposes including: food and drink; making ropes and containers; medicine; building houses, and braiding. Between 1800 and 1930, coconut and copra production became a huge colonial business. The number of coconut palms in the Pacific region increased by 60 to 100 times. During this period, the agricultural landscapes and practices were profoundly and brutally modified. Many islanders were forced to work on coconut plantations and in the copra-drying ovens. On many islands, the population was decimated by diseases such as measles imported by Europeans.

During colonial times, planting techniques on the atolls consisted mostly of clearing all the natural vegetation, letting it dry for a month and then burning everything. These planting techniques were clearly harmful to the biodiversity of endemic species. They were also damaging for the coconut palms, especially from the point of view of conservation of genetic diversity.

For a better understanding of these dynamics, the reproductive biology of the coconut palm must be described. Except for modern hybrids, there are two main kinds of coconut palm; 90 to 95% belong to the Tall types whereas Dwarf types are mainly found elsewhere in gardens. The coconut inflorescence contains both female and male flowers which may or may not be mature at the same time. Tall types are preferably allogamous (outcrossing), meaning that each palm is preferably pollinated by pollen brought from another palm by insects or wind (Konan *et al*. 2008). Most Dwarf types are autogamous (self-pollinating), meaning that a Dwarf coconut palm is generally both the female and male parent of its progeny. In Polynesia, including Fiji, some interesting allogamous Dwarfs called “compact” also occur.

Coconut landraces (mainly Tall type), which were created over millennia by the Pacific islanders, were progressively diluted in the mass of coconut palms selected only to produce copra. The cataclysmic socio-economic changes that affected these islands exacerbated the erosion of both traditional knowledge and biological resources. We estimate that at least 50% of the coconut varieties created by Pacific Islanders over centuries are already lost, and the extent of loss of traditional agricultural knowledge is certainly much higher. If we imagine living in a village, with no books and no computer, and where more than 90% of the villagers will die within a short period, how much traditional knowledge will survive?

Nowadays, traditional coconut plantations in the Pacific region show a high level of variability, especially regarding fruit shape and weight. In the middle of a copra coconut plantation, a few palms of traditional Polynesian varieties survive, or a mixture of these varieties. Some palms produce long coconuts with a thick husk, which were used for making ropes, some produce large shells with flat bottoms, which were used as containers, some have soft and/or sweet kernels or husks, and

some produce sweet and tasty coconut milk. At least half of the Polynesian coconut varieties conserved in *ex situ* genebanks were collected from such mixed populations.

A recent trend is to promote "local Tall varieties". However, in many cases, what is called "a local variety" by farmers and agricultural officers is no longer a single variety, but an uncontrolled mixture of various traditional varieties and sometimes modern hybrids. The "best palms" harvested for coconuts are often natural hybrids between traditional varieties or progenies of these hybrids. Coconuts are harvested on palms close to Dwarf x Tall hybrids, and sometimes directly on the Dwarf x Tall hybrids considered as traditional varieties. Such a situation was encountered in Avatoru village on the Rangiroa Atoll (Tuamotu, French Polynesia). Here grew a mixture of some local Tall varieties, Malayan Yellow and Red Dwarfs, a dwarf called "Tahitian Red Dwarf" (but originating from Papua New Guinea), Compact Dwarfs from the Cook Islands, the Brazilian Green Dwarf, the hybrid Brazilian Green Dwarf x Rangiroa Tall, the hybrid Malayan Yellow Dwarf x West African Tall, and progenies F2 and F3 from these hybrids. All this mixture of varieties, many of them imported less than 50 years ago, is already called "the variety of our ancestors" by many of the villagers.

4. Some contemporary attitudes of Pacific islanders towards the coconut

4.1. Regarding the respect due to the coconut palm

Numerous public lectures were organized across Polynesia. Some were conducted in large conference rooms, others in small villages of remote islands. From both anthropological and personal points of view, the smallest were the most appealing. One of the most significant was held on Moorea Island (French Polynesia), at the Gump Research Centre of Berkeley University. We had vital contact with Ms. Hinano Murphy and the other members of the *Te Pu Atiti'a* cultural association. The elders from Moorea honored the meeting with their presence.

A film was presented to illustrate the production of coconut hybrids: the inflorescence of a dwarf palm is manually unwrapped before its natural opening; then all the spikelets containing male flowers are cut; all the remaining male flowers are removed in order to keep only female flowers. When these female flowers become mature, a mixture of talcum powder and pollen is sprayed onto the inflorescence.

At the end of the lecture, although there were interesting exchanges with the elders, nothing really important was shared. One week later, we met again with Ms. Hinano Murphy hoping to receive an indirect feedback: in fact, when watching the film, the sages were deeply shocked by the disrespectful and brutal way the coconut palm was treated.

The legitimacy of man's direct intervention on plant reproductive parts using implements or tools is not accepted in all cultures: this is a fact of society. The issue of man's legitimate actions on his environment was studied by Haudricourt (1962) who compared sheep and yam to analyze the relationships which man develops with domesticated species. Haudricourt (1962: 44) quoted the work of Mencius, a Chinese thinker born around 300 BC:

> A man, troubled to see that his rice was not growing, pulled at the stems. On returning home, the fool told his household: 'Today I am very tired, I have helped the crop to grow'. His sons ran to see his work for themselves. The stems were already dry. […] Those who use violent means […] do like this madman who pulled up his crop. Their efforts are not only futile, they are harmful.

Haudricourt put forward a parallel between the treatment of plants and the treatment of people in human societies: man must not be placed in a position of cause, otherwise the effect is negative.

4.2. The "coconut complex" of modern Polynesia

The modern representation of the coconut palm by Pacific islanders often appears ambivalent. Caillon (2007:87) described the coconut palm's modern change of status on Vanuatu: the coconut is perceived by local people as the tree "of the Whites" mainly for its relation to the place. She analyzed the physical and social place of the coconut palms among their new spaces, the coconut plantation:

> It is defined as the space "of the Whites" from which practices and biological material have been inherited. Its new economic function is perceived as an unavoidable constraint since copra is the unique source of income for the people of Vêtuboso. Coconut plantation is also a "greedy" space encroaching on the space of crop gardens and of the forest inhabited by spirits. It also definitely "captures" land among a family during few generations because of coconut palm longevity and multiplication.

Quite similar representations are found in Polynesia, although the expression "plant of the Whites" was not met. A recent Polynesian book dedicated to the coconut palm (Association culturelle Te Reo o te Tuamotu 2005) is introduced by lyrics of an old Paumotu song: "*Nâku teie hakari, na toku Tupuna!*" meaning "This coconut is mine! It comes from my ancestor!". The authors allude to the lyrics as follows: "Indeed, since the coconut has developed, land claim has become common, even when dealing with only one palm, as shown in the statements of two individuals claiming the same coconut tree in this ancient *pirari*."

Although this "relation to the place" is significant, these ambiguous representations also come from memories of the hard colonial times, from westernization and from the simplistic coconut symbolism conveyed by globalization.

In the past, people were forced to work on coconut plantations or in smoky copra-drying ovens, during a period when many died from imported diseases. Studying the Tuamotu archipelagos, Ravault (1980:97) stated:

> The systematic expansion of coconut plantations, which was continued until the 1930s, not only led to the disruption of land occupation, it was also responsible for the disappearance of all the subsistence system based on the exploitation of land resources. By producing copra, Paumotu came almost seamlessly into the monetary economy. In exchange for copra, which is their return freight, commercial boats offer islanders western products and foods that have soon become "indispensable" to islanders.

During a survey on the Cook Islands, we succeeded in locating a palm from the "Sweet husk" type (see above), named *niu mangaro* there, with considerable difficulty. The survey was conducted in conjunction with a government agricultural officer. He took a tender coconut and started to chew the sweet husk. Then he stopped, saying: "I do not want people here to see me eating *niu mangaro*, because they will say I am a poor man". The consumption of traditional varieties is perceived as socially stigmatizing, even by an agricultural officer supposed to be aware of the value of biodiversity. On the other hand, the consumption of imported food is considered a mark of modernity and richness.

Howard and Borofsky (1989:283) discussed the impact that the discovery of Polynesia had on Western societies: "The "noble savage" depicted by different writers as residing on one or more Polynesian Islands became a vehicle for criticizing shortcomings in European society…". In the collective Western imagination, the coconut palm has become the ubiquitous and anonymous symbol of exoticism and tropical beaches. It is well known that the image of the coconut palm is now widely used by advertisers to market not only tourism but also numerous products ranging from fashion accessories to financial investments. The combination of coconut palms with "hammocks" or "monkeys" sometimes reinforces the stereotype of a peaceful paradise, away from the stresses of everyday life, which is definitely not Polynesia. Pacific islanders are reluctant when confronted with such false representations which standardize the tropics and deny their cultural identities.

A coconut palm, more than 8 meters high, was located just behind the small house of a villager in Tuvalu (Bourdeix, pers. obs.). The palm was used to produce toddy by cutting its inflorescences daily to harvest its sweet sap. The survey team talked for a few minutes with the villager. Then, very politely, as had been done many times before, the local agricultural officer asked him to provide a few drupes. This time, the reply from this villager was quite harsh: "Are you stupid? I never climb the coconut palm, I am not a monkey!" Later, we had confirmation that it was this same man who climbed his palm twice a day to harvest sweet toddy. Thus, our hypothesis to explain the villager's attitude is the following: his reluctance could be a reaction to the presence of a stranger, perceived as representative of western culture and its simplistic symbolisms.

The cover page of the book "Developments in Polynesian ethnology" (Howard and Borofsky 1989) provides a perfect example of the simplistic use of coconut symbolism: it shows a pink drawing of a coconut palm without fruit. Ethnology examines the social and cultural characteristics of human groups so the scientists could have illustrated their work with a human image, for example a picture of Polynesians engaged in activities specific to their culture. Even experienced ethnologists can get caught in the trap of stereotypical coconut symbolism.

For the tourism industry, evolving in a competitive environment, it has become increasingly important to stand out from the standard fare that tourism offers (Bourdeix *et al*. 2011a). Many tourists are no longer satisfied by exotic golden beaches bordered by anonymous palms, and those who are will probably choose a cheaper destination than Polynesia. Coconut palms should no longer serve as symbols of anonymous and false exoticism: they tell true stories, specifically related to Polynesian cultures in the framework of an ecotourism approach.

In French Polynesia, during 2009 and 2010, we were told by three separate informers that an important Polynesian political leader said: "If France leaves French Polynesia, you will have to teach your child how to climb the coconut palms again". Leaving the political aspects aside, this perfectly illustrates the ambiguous representation associated with the coconut palm, representations that we will emphasize as the modern "Coconut complex" of contemporary Polynesia.

The principal author of this chapter considers this ambiguous representation to be the main reason why it is so difficult to convince stakeholders and institutions in French Polynesia to act in favor of coconut genetic resources. Although coconut is the main crop in terms of area planted, there is no Coconut Research Institute and no surviving coconut genebank in French Polynesia (whereas there is a Vanilla Research Institute, an international banana genebank, and even a Monoï Institute). Although proposals have been submitted, French Polynesia is not a member of the two main international organizations dealing with coconut: the Asian and Pacific Coconut Community (APCC) and COGENT.

For reasons linked to both colonization and globalization, many Pacific islanders simultaneously "love" and "hate" this emblematic palm. Their attitude towards the coconut is often a mixture of reverence and contempt. Nevertheless, in short discussions with local people elsewhere in the Pacific, they rapidly change their mind and acknowledge the coconut palm as an integral part of their traditional cultures. Jean Kape (President of the Paumotu academy) chose the name "*Nâku teie hakari!*" *i.e.* "This coconut is mine!" for the book on coconuts by the "Association culturelle Te Reo o te Tuamotu", in order to emphasize the coconut as an integral part of the Paumotu culture.

5. From Polynesian traditional knowledge to conservation strategies

By combining ancestral Polynesian practices with the recent progress made in social and biological social sciences, a rational strategy for the conservation of genetic resources and associated traditional knowledge could be implemented.

5.1. From traditional knowledge to the "*Polymotu*" concept

In classic coconut *ex situ* genebanks, coconut cultivars are conserved as accessions, generally planted close together in the same fields. Each accession usually contains 75 to 100 coconut palms from the same cultivar. To reproduce accessions in *ex situ* genebanks, the technique of controlled pollination with bagging of the inflorescence is used (Konan *et al*. 2008). For coconuts, this technique is very costly. It requires a well-equipped laboratory, well-trained technicians able to climb the palms and a huge amount of manpower. Not all the genebanks can afford this.

The lifespan of such accessions is only 25 to 30 years. After this period, most non-dwarf coconut varieties reach 15 m high or more. At this stage, it becomes difficult to climb the palms. It is therefore necessary to rejuvenate the accessions before the inflorescences become inaccessible. In the Ivory Coast African genebank, workers use costly triple ladders that can reach a height of only 14 meters. In many other

places, palms are climbed mainly unaided, which is risky. Rejuvenation programs require roughly 75 palms to be climbed about 15-20 times each. Production of the 200 drupes needed for the duplication of one accession will demand 18 months of preparation and will cost more than 1,600 USD, in the context of low salaries in Ivory Coast. Only scientists with healthy research budgets can afford to order varieties from classic *ex situ* coconut genebanks. Almost all farmers cannot afford to do so.

Alternatively, the coconut palms could be planted in geographical and reproductive isolation, as was done by Polynesians in their traditional conservation areas. For instance, when a small isolated island is planted with only one variety of coconut palm, breeding occurs only within this variety and certified coconuts are naturally produced for farmers.

In this way, the constraints linked to the heights and ages of the palms are removed. Instead of climbing the palms to carry out controlled pollination, people only have to wait for the coconut to fall naturally to the ground. Open-pollination will provide true-to-type and cheap coconuts. Thus, the same accession can be kept as long as a sufficient number of palms remain alive in the field. In most cases, the duration of a coconut accession will then be extended to 75 to 100 years. Even if some of the palms die, there is no need to remove the remainder, as is done in a classic genebank. Dead palms can be replaced by new ones, without removing the old palms remaining alive. Extending the lifespan of a coconut accession from 25-30 years to 75-100 years represents huge savings in time, manpower and money.

The Polynesian practice used for traditional conservation areas is to plant only one coconut variety on each small island. This practice has served as a basis for defining a new conservation concept called *Polymotu*, which is to use the geographical isolation of special sites for the conservation and reproduction of individual varieties of coconut, other plant species and even animals. When compared to the initial Polynesian model, the *Polymotu* concept has evolved in several ways (Bourdeix *et al*. 2012b):

> 1. The sites are extended to any place where reproductive isolation can be obtained; they may be islands but also small isolated valleys, cities, or inland areas with pollen barriers made of coconut palms or other tree species, be they wild (forest) or cultivated (rubber, oil palm).
>
> 2. The species conserved may be coconut, together with other plant species or even animals. In Polynesia, it is envisaged that varieties of *kofai* (*Sesbania coccinea* subsp. *atollensis*) and coconut crab (*Birgus latro*) will be conserved on the same islands as coconut for an economy of scale.
>
> 3. It is recommended to plant up to three coconut varieties on the same site and to identify the different kinds of seedling using phenotypic markers at the nursery stage. In Samoa, a Green Tall and two Red Dwarfs will be planted together in order to conserve both Tall and Dwarfs and to produce seedlings of Tall, Dwarfs and Dwarf x Tall hybrids for farmers.

Conservation programs for protected areas and plant genetic resources are evolving in similar ways, beginning with a focus on a single species and expanding to ecosystem strategies that involve the participation of local people (Orlove and Brush 2009).

5.2. From ethnobiology to conservation strategies and policies

Regarding French Polynesia, our first recommendation was to devote the smallest islands to the conservation of traditional varieties of coconut and other plant species. In 2011, we visited Tahaa (in the Windward group of the Society Islands, French Polynesia). The action undertaken by the Service of Rural Development was the opposite: the plantation of coconut hybrids was strongly favored in the belt of numerous small *motu* surrounding the island. Our second recommendation deals with planting material. In French Polynesia, the same unique coconut hybrid, presented as a panacea, has been released to farmers over the last 20 years but they, especially farmers from Tuamotu, no longer want to plant this hybrid. Similar situations occur in some other Pacific countries, so the recommendation was formulated at the international level.

Created in 1992, the International Coconut Genetic Resources Network (COGENT) aims to strengthen international collaboration in the conservation and use of coconut genetic resources, to promote improving coconut production on a sustainable basis, and to boost the livelihoods and incomes of coconut stakeholders in developing countries. COGENT now gathers together 39 coconut-producing countries (representing more than 98% of global production) 6 of which come from the Pacific region: Kiribati, Papua New Guinea, Samoa, Solomon, Tonga and Vanuatu. To support regional and global projects, COGENT and Bioversity International have provided funds and technical backup in 30 countries. This has enabled 288 research projects, training courses, meetings and workshop activities to be conducted to support research of regional and global significance.

Bioversity International organized the 16th COGENT Steering Committee meeting from 8th to 10th July 2012, in Kochi (Kerala, India). As a key outcome of the meeting, the COGENT Steering Committee and participants from 18 countries endorsed 10 major international recommendations. The studies summarized in this chapter contributed to the development of 4 of these 10 recommendations, now fully available on the COGENT website (Bourdeix 2012).

5.3. First implementations of the *Polymotu* concept

Tetiaroa is an atoll in the Windward group of the Society Islands of French Polynesia. The atoll is located 53 km north of Tahiti. It stretches across a total surface area of 585 hectares of sand which is divided into 13 *motu* (islets) of varying size. Tetiaroa is rented under a long-term lease by a private lessee. We obtained the agreement of the lessee and the private company Beachcomber SA to use 5 locations (4 *motu* and a small peninsula) for the conservation of coconut varieties using the *Polymotu* concept. We proposed to remove about 1,500-2,000 coconut palms in order to favor endemic vegetation and bird nesting, and to replant about 500 coconut palms from five traditional Polynesian varieties (Fig. 8). In 2010, we started to replant one of the islands of the Tetiaroa atoll with a very rare form of horned coconut having a strong ecotourism value (Bourdeix *et al*. 2012b). This astonishing variety is critically endangered and only a few palms remain in French Polynesia. The main population was located on the Motutunga atoll in the Tuamotus but palms were recently destroyed by Polynesian mariners (Henri Belveze and Tafai Moati, pers. comm.). To date, this

project has not been developed further due to a lack of commitment from Polynesian institutions and a lack of finance from both institutional and private partners.

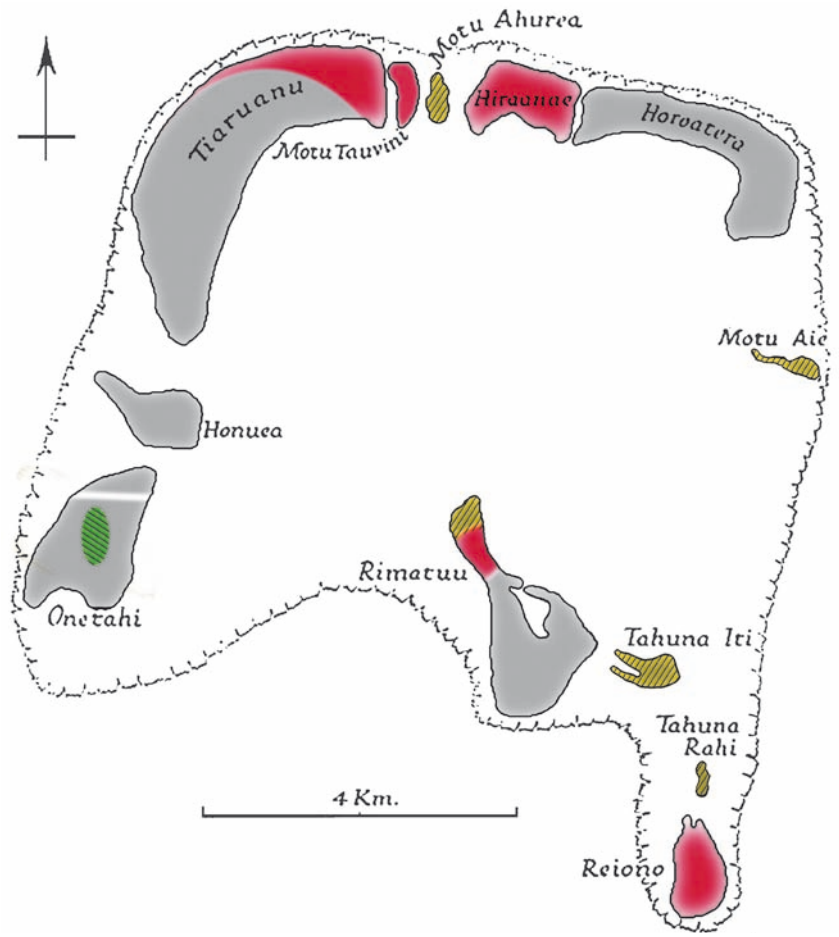

Figure 8. Proposal for implementation of the *Polymotu* concept on Tetiaroa (French Polynesia). In red: zones where the coconut palms should be removed; in yellow: 5 sites for conservation of 5 traditional Tall-type coconut varieties; in green: zone for conservation of Dwarf-type coconut varieties.

Respect for tradition can foster economic competitiveness. The amazing traditional variety *niu afa,* created by ancient Samoans for making ropes from the long resistant coir fibers of the husk, produces the longest coconuts in the world (see Figs. 7 and 9). Nowadays, Samoans use much fewer coconut ropes than in the past. Until recently, *niu afa* was in danger of extinction. A project funded by the Global Crop Diversity Trust and led by the Secretariat of the South Pacific Community aims to multiply, conserve and use this variety. The plantation of at least 2 small islands with *niu afa* is planned and negotiations are presently being conducted with the families and clans owning these islands (in September 2012). A prestigious resort organizes regular visits to the small Nuusafee Island (Samoa). This tour will impress clients more if Nuusafee is planted with *niu afa* and provides traditional certified coconuts to farmers.

Figure 9. The *niu afa* variety and a young Samoan on the island of Nuusafee (Samoa).

The *niu afa* variety produces big coconuts with sweet milk to drink and a tasty kernel. It could generate and service a lucrative "niche" market. Samoan communities in Australia and elsewhere will prefer to buy products made from this special variety bred by their Samoan ancestors. Making better use of their heritage varieties, Samoan farmers and small producers of virgin coconut oil will increase their incomes and improve their livelihoods.

Conclusion

During a survey conducted in 2010 on Moorea Island (French Polynesia), a Polynesian farmer was interviewed about the rare, precious and disappearing sweet husk varieties. He replied: "- I had one *kaipoa* coconut palm on my farm, but I cut it down two years ago. - Why? - Over 10 years, I was unable to harvest a single fruit: all were stolen and eaten by children from the neighborhood." We consider this example as emblematic of the dynamics presently occurring in French Polynesia: a traditional variety remains appreciated by children, the next generation of Polynesians; the farmer is not aware of the rarity and the cultural value of the resource; for various reasons - in this case overuse due to rarity - the farmer neglects or destroys the resource.

Both traditional coconut varieties and associated knowledge are continuing to disappear and there is a huge and urgent need to safeguard that which remains. A century of colonial, capitalistic and industrial coconut cultivation should not allow the millennia over which Pacific islanders have patiently bred their traditional varieties and developed associated knowledge to be forgotten. Both varieties and knowledge should be preserved because of their high cultural value and their economic interest. The coconut industry is facing an important revival linked to the diversification of coconut products. In the future, some traditional varieties could be vital for developing new products and markets.

The Polynesian knowledge related to traditional conservation areas has strongly contributed to developing new concepts and strategies in the conservation of genetic resources and biodiversity. Implementing the *Polymotu* concept strengthens the links between people, landscape and biodiversity. Decision-makers at the local, national and international levels should adopt effective portfolios of strategies and gender-sensitive guidelines to meet the needs of stakeholders, and especially to ensure both the effective conservation of coconut genetic resources and associated knowledge, and the availability of good, diverse planting material for replanting programs. Significant outcomes will be the safe conservation of the representative biodiversity of coconuts and an increased availability of certified coconut drupes to mainland farmers. Benefits will accrue to all those stakeholders who rely on coconuts for their livelihoods and all coconut consumers - *i.e.* all Polynesians.

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